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WEST EUROPE REPORT
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NATIONAL MISSION TO PROMOTE NUCLEAR, OTHER DISTRICT HEATING

Paris INDUSTRIES & TECHNIQUES in French 20 Nov 80 pp 26-30, 32, 34

[Article by Martine Castello]

[Text] Heat recovery in industry amounts to 350,000 tons of petroleum equivalent a year. Considering the many sources available, this figure should be close to 800,000 TEP [Tons of Petroleum Equivalent] in 10 years. But we will still have to "tame" the wastes from refineries, chemical plants, cement plants, etc. For power plants, both thermal and nuclear, several experiments are now in progress and many projects are under construction.

Many industrial activities, with electricity production in the lead, produce significant amounts of thermal wastes. In most instances, these calories are lost. Yet it is possible to recover and use them--either as they are, or after some treatment. This is--along with the promotion of coal, of geothermal heating, and the incineration of household wastes, and through the development of distribution systems for the heat thus produced--one of the methods the government has chosen to meet its energy policy goals by 1990. Last April the minister of industry decided to set up a national mission for heat promotion and distribution, and also to establish an association for the promotion of heat systems, called "Promocal." Seven public establishments are now part of this association, including EDF [French Electric Company], the CEA [Atomic Energy Commission], the COMES [expansion unknown], and of course the Agency for Energy Conservation. Promocal's role is to coordinate these organizations and to promote projects with a variety of users, with the main users being local communities. But beyond these good intentions on the part of the government, what is really the status of new energy developments in France? Heat systems do exist; there are about 180, commonly called "district heating systems." They consume approximately 2.3 million TEP. Of this total, 1,650,000 TEP come from hydrocarbons (primarily heating oil), 300,000 TEP from coal, and 350,000 TEP from industrial heat sources, from wastes, and from geothermal energy.

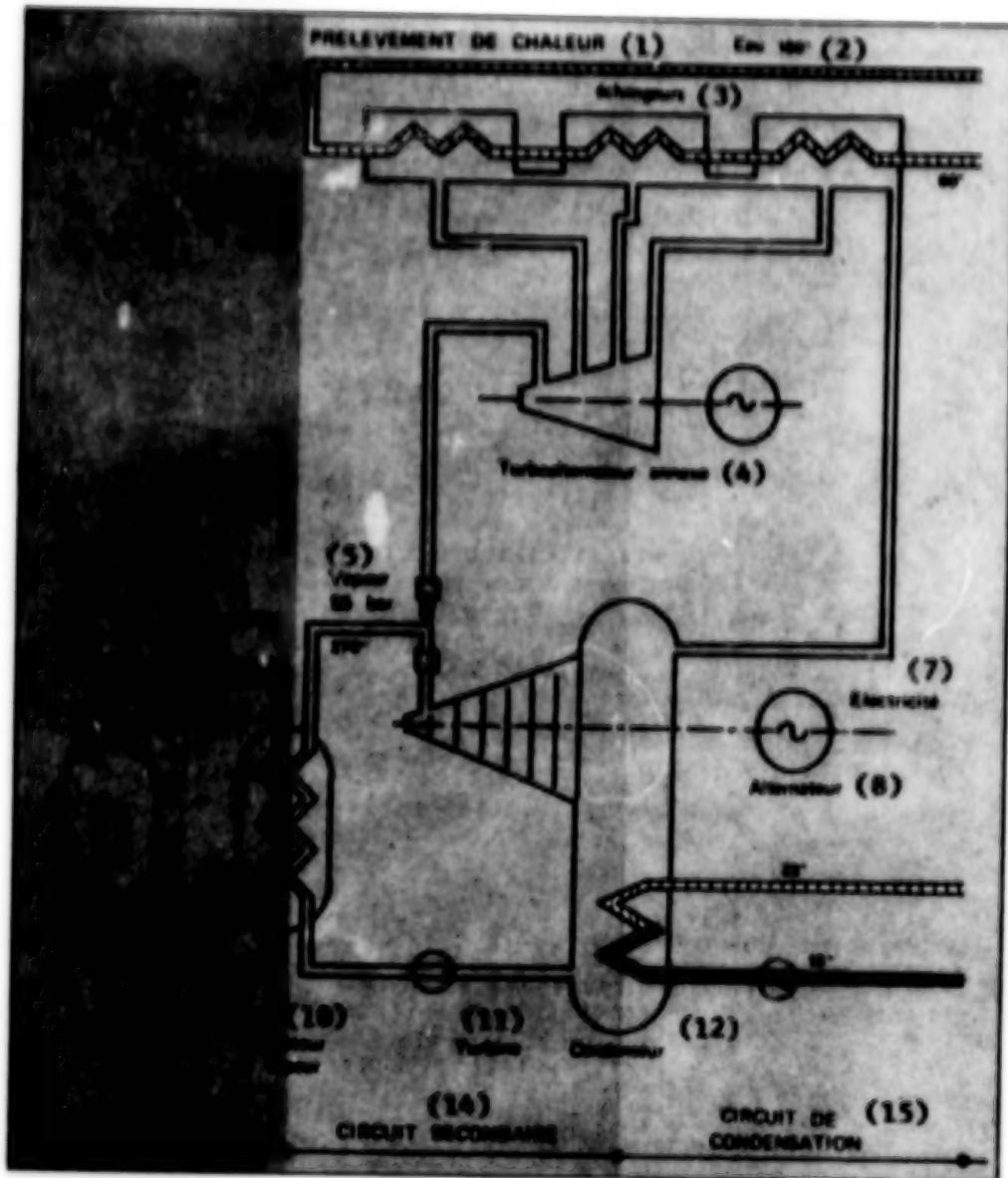
Industrial Heat for District Heating

Consumption in 1990 is estimated to be 4 million TEP. The energy conservation policy calls for a better use of incinerated household wastes (0.5 million TEP instead of 0.35 million), and research on new sources, such as industrial wastes (0.45 million TEP). We should not forget that of all of France's energy consumption, over half requires, or can use, hot water or steam produced in boilers. Furthermore, a third of the needs require only low temperatures. Heating buildings and water for sanitation purposes requires water between 50° and 70°C where it is used, and industrial heating requires only low temperatures (heating greenhouses and fish-hatcheries can be done with only 15°C temperatures). For these reasons, the possibilities of recovering thermal effluents are, at least in theory, quite good. These effluents appear in a variety of industrial sectors: wastes from petroleum refineries, from the steel industry, from thermal or nuclear power plants, but also wastes from mechanical, electrical, chemical, and glass industries, from coke plants, from cement plants, from lime kilns, from agricultural and food processing facilities, etc. Industrial thermal wastes, which can be recovered (excluding electric power plants) appear in three forms: smoke (combustion gases) at 150-200°C, drying or cooling air at 100-120°C, and cooling water at 70-90°C.

Saving 1 Million TEP in 1990

The only experiments that have been done in industry now consist of recovering heat at 90°C from refineries. Four heat recovery systems are now in operation, based on this model. They share in common a low-temperature hot water distribution system which uses recent technological developments (steel, preinsulated, cast iron, and laminated structures). Their total production does not come to 15,000 TEP a year. No distribution systems had to be created for them. The pipes lead to a pre-existing boiler at Valenciennes and Toulouse, and to two already existing boilers in Reichstett. This heat is used for district heating. In 1990, based on an optimistic forecast for this type of system, the energy saved should be 1 million TEP. This supposes that the facilities established in urban areas will expand so that they will be able to collect heat from a variety of industrial facilities, both urban and suburban, like what has been planned south of Lyon between four Rhone-Poulenc plants, two Ugine Kuhlmann plants, and the Feyzin refinery.

The thermal energy taken from electric power plants is quite different. There are two types: heat coming from the cooling circuit of the condensers, or heat taken from the steam expansion cycle.



In nuclear power plants, the heat recovered from the condenser's cooling circuit is used for fish hatcheries and for agriculture; heat taken from the steam expansion circuit is used for district heating systems.

Key for Preceding Figure:

1. Removal of heat
2. Water at 180°C
3. Exchangers
4. Attached turboalternator
5. Steam 55 bar
6. Pressurized water 155 bar
7. Electricity
8. Alternator
9. Reactor
10. Steam generator
11. Turbine
12. Condenser
13. Primary circuit
14. Secondary circuit
15. Condensation circuit

Water from the condensers' cooling circuit can be made available to any user after it goes through the condensers. The use of this water has no effect on the production of electricity, but because of its limited temperature range--15-35°C--it can be used only for agricultural purposes or for fish hatcheries. In order to obtain temperatures compatible with industrial uses or for heating buildings, the heat must be taken from the steam expansion cycle. The characteristics of the heat supplied are: up to 500°C for thermal power plants and 260°C for nuclear power plants. For reasons concerning the quality of the water from the steam generators and radiation safety in the case of nuclear plants, a heat exchanger is required between the turbine's steam circuit and the external heat circuit. For conventional thermal plants, the quantity and the characteristics of the heat depend on modifications which may be made. The calories are taken from part of the steam. Instead of being expanded up to 25 or 30°C, the steam will be condensed between 110° and 180°C in order to produce hot water. For district heating we recover, on one hand, the energy not transformed into electricity because of the interruption of the expansion process, and on the other hand, the heat that would have been released into the atmosphere after complete expansion.

This type of facility, equipped with a non-condensing steam turbine, is the oldest and the one most used by heat systems. Although the equipment comes in all sizes, the technology seems best suited for facilities between 100 and 500 MWe, for steam. The most spectacular and the most advanced project now is at Dunkerque. This is designed to serve approximately 15,000 existing housing units (120 oil and gas furnaces), with a 31-kilometer network.

This is supplied by taking heat from the turbine of EDF's thermal power plant in Dunkerque (4 x 125 MW) burning 5 billion cubic meters of gas from the blast furnaces of nearby steel mills. The annual supply of heat produced should be 176,000 kilotherms, which would mean energy savings of 23,500 TEP.

Refineries: Significant Heat Recovery Potential

Refineries	52 percent
Mechanical and electrical industries	7 "
Steel	7 "
Chemicals	6 "
Glass	6 "
Coke ovens	5 "
Cement, lime	3 "
Agriculture and food processing	3 "
Other	11 "

Distribution by sector of the plants which consume over 500 TEP a year (excluding electric power plants). The thermal wastes from these facilities can be used to produce hot water at least 90°C in temperature.

Nuclear Plants: Irregular Heat Supply

Supplying heat from nuclear power plants is a "hot topic" for people involved in energy conservation. But the full scope of the problem must be understood. Because of their design, nuclear power plants do cause problems when attempts are made to recover heat from them. The first problem concerns the selection of the site of the plant. For safety reasons, the plant is located far from densely populated areas; this causes transport problems and losses when the heat is taken to the closest city. A nuclear power plant is located in a stable geological space which meets standards which are only rarely compatible with agriculture, fish hatcheries. The second problem lies in the operation of the plant. There can be no possibility of changing the standardization of the equipment or of modifying the operating conditions. Therefore, the heat is not supplied in a regular way (shutdown of the plant for reloading of the nuclear fuel, etc.). The potential user must for that reason have parallel production facilities in order to cope with any stoppage in the heat supply, no matter how long such a stoppage may last. But given these reservations, it is possible to use nuclear power plants as a heat source. For the nuclear plants (just as for thermal plants), the heat comes from two points: the condenser's cooling circuit and the steam expansion cycle. The water from the condenser's cooling

circuit can be made available to users after its passage through the circuit. In units with atmospheric cooling in a closed circuit with coolants, it is possible to take 1 cubic meter per second from the cooling circuit after the condensers.

The use of this free hot water has no effect on the production of electricity. The temperature of this water is limited, ranging from 15°C to 30°C, so it is perfectly appropriate for agricultural and fish hatchery uses. In order to encourage this development, EDF, in cooperation with agencies of the ministry of agriculture and other related organizations, has set up an experimental station next to the Saint-Laurent-des-Eaux power plant. In the station are 3,000 square meters of greenhouses, 3 hectares of crops which are heated and grown outside, and 8,000 square meters of ponds.

+ 9°C for Pike

The cooling of the Saint Laurent 1 and 2 units is done in an open circuit. This supplies water that is 9°C warmer than the water of the Loire, whose temperature varies between 1°C and 4°C during the winter and 23°C and 26°C during the hottest part of the summer. The amounts available are much greater than all the uses now being considered. But two electric furnaces had to be added in order to handle any possible shutdowns of the plant and for use during the most critical periods of the winter. In order to make the operation of the heat pumps more economical, they are only used during the off-peak hours; the hot water is stored in a pool with a capacity of 250 cubic meters. The greenhouses are heated by means of a rather original method: the water circulates at a slow speed (several millimeters per second) in a duct which consists of two strips of PVC 40 cm wide which are attached on the edges and from place to place. Several ducts are placed on the soil parallel to the cultivation beds. The water, as it cools, gives off its heat to the air by radiation and convection, and to the soil by conduction. Three other more conventional methods are also used. These entail heating by tubes in the air, by underground pipes, and by circulation of hot water in metal tubes which are identical to the ducts. The results are highly satisfactory: vegetable production (tomatoes, cucumbers, and lettuce) is larger and earlier. The fish hatcheries are designed to repopulate the Loire water with pike. The entire production sequence is handled, from the time eggs are laid to the fingerling stage. The water comes from the open circuit of the power plant (the closed circuit can not be used because of the chlorine it contains). The water is constantly renewed by pumping and by gravity flow. In this way the quantity can be controlled, and, by mixing, the temperatures. There are three advantages in heating the pond water. The period of reproduction for each species

is advanced, there is growth and production throughout the entire year, and for some types of fish there is a definite weight increase. But offsetting these advantages, there is the fact that while the calories are free, the cost of their transfer has to be paid by the user. The user also has to respect the conditions governing the intake and release of water, with the constraints concerning the dilution of effluents.



Supplying heat for the Lyon region from heat recovered from the Bugey nuclear power plant. This project had to be dropped. The amortization of the 50 kilometers of heat ducts was uncertain.

One Problem: Transporting Heat

The heat taken from the steam expansion cycle is not free. Its price depends on the time and season. It is also determined by the nature of the heat supplied and the type of heat-tapping installation, considering the equivalence between heat and the electricity not produced. The heat taken here is often destined for industrial uses or for heating buildings. The original source is the steam produced by steam generators. It is drawn off above the main turbine. This steam feeds into either a steam transformer or a non-condensing turbine. A heat transformer is provided for each unit supplying heat; it is not interconnected with the original steam in order to avoid any possible contamination. This method can supply steam at 40 bar, at a temperature of approximately 260°C.

and very hot or hot water. The thermal power is 300 thermal MW for 900 MWe units and 450 thermal MW for 1,300 MWe units. However, there are still many difficulties remaining, and this type of facility has not yet been developed in France. As an example, we could mention the cancellation of the heat recovery project associated with the Bugey nuclear power plant. This was to have supplied heat to the Lyon region. The problem was paying for the 50 kilometers of transport ducts. The investment costs were too high in relation to the projected savings, and the project was halted. Now there is only one such development in the entire world, at Bilibino. This has four units, each supplying 12 MWe and 25 Gcal per hour of heat. These units were placed in service between 1974 and 1976; they are located in eastern Siberia beyond the polar circle, 1,000 kilometers north of Kamchatka.

The necessity for transporting the heat and the magnitude of the investments involved do place a severe burden on these projects, but the rapid rise in energy costs will cause projects whose cost had once been considered prohibitive to reappear. Then heat will no longer be allowed to dissolve slowly and uselessly in the atmosphere.

7679

CSO: 3102

WORLD'S LARGEST WIND-POWER PROJECT NEARS COMPLETION

Background Information

Stockholm NY TEKNIK in Swedish 30 Oct 80 p 24

(Article by Mikael Holmstrom)

(Text) The largest investment in wind-power is presently being realized in an old wooden house in Karlskrona. The designers are putting a finishing touch to the two power plants that the Karlskrona naval yard will deliver to Sweden and to the United States. The production of the power plants that will be delivered in a year has already started.

The old chief engineer's home with its leafy yard is not exactly the kind of environment that you would connect with this kind of work.

The naval yard engineers are having busy days. Now they have to meet the promises of the quotations and the time limits of the contracts.

The collaboration of the Karlskrona naval yard and the American Hamilton Standard has so far been successful.

Boeing was defeated in the United States. In Sweden the naval yard and the Karlskrona Mechanical Workshop received the orders for the two power plants that have to be finished in 1982, in Skane and in Gotland. Kockums, Gotaverken as well as Saab-Scania and Stal Laval, who were collaborating, did not receive any contracts. The naval yard is thus involved in the latest and most extensive separate wind-power project in the world. The leader of the project is civil engineer Karl-Erik Hallsten:

"When I heard about wind-power in the middle of the 70's I was working at Kockums. I thought that this would not be something that they would want to invest in extensively. I thought that whatever problems would arise would hardly be difficult to solve."

Karl-Erik Hallsten cheerfully admits that he was proven wrong. The Karlskrona naval yard is already involved in the competition surrounding the first commercial plant of the world: 25 power plants for Hawaii. Long work hours are being spent on the construction problems that have to be solved.

The contact between Karlskrona and the United States is maintained each day per telephone and telex. During the visit of Ny Teknik the electrical system of the American power plant and the turbine blades of the Swedish plant are being discussed. While the work is in full bloom the workshops of the naval yard are building the machine bed of the power plant. And in Maglarp in Skane a 3.5 m deep hole with a 20 m diameter is being dug for the power plant.

Totally Different Traditions

This work is not only an encounter of the engineers of two countries but also two totally different work methods.

The many hundred years old naval yard filled with traditions will be combined with the latest computerized constructions of the airplane industry. Normally Hamilton Standard manufactures advanced airplane components and propellers.

This is how the work is divided up:

In the United States Hamilton Standard performs the systems analysis, the construction and the manufacture of the propeller blades. The turbine hub as well as the systems for the setting of the blade angle and control systems are mostly made in Sweden.

The Karlskrona naval yard is responsible for the design and the construction of the engine house, the tower and the foundation as well as the delivery to Sydkraft. The operation in Maglarp at Trelleborg will start in October 1981. The date of delivery is March 1982.

The American power plant will be set in operation at the end of 1981 and has to be transported from Karlskrona already in June 1981. Then the naval yard delivers the entire engine house, the blades and the blade angle setting mechanism to the United States.

The turbine blades for the Swedish plant will be transported from the United States in May 1981. This means in practice that these two power plants are built simultaneously.

The difference is that the Swedish version will have a generator of 3 MW and the American version a generator of 4 MW (alternating 60 cycle current). The difference is based on the fact that it is windier at the location of the American construction.

In Maglarp the power plant will be intensively monitored for 3 years (the life span is at least 30 years). Thereafter the orderer, the Committee for Energy Production Research, will have enough material for the Parliament to make a decision about a major investment.

That is far too long a time according to the engineers.

Maglarp May Not Become a New Marviken

"Two years of testing and experience is enough. I do not understand what more you can get out of waiting for 3, 4, 5 years," says John McIsaac, who has for 1 year worked in Karlskrona as a liaison with Hamilton Standard in the United States. "I know that private investment companies are very interested in our power plants--not because they represent interesting technology, but because they want to invest money and make profits. If these power plants are manufactured in series and you consider the price per kilowatt hour wind-power is today superior to coal, oil and solar cells. We are only competing with nuclear power with regard to price," says John McIsaac.

The Swedish engineers have a more subdued view of the job. They make a point of explaining that they are building a prototype for 45 million crowns, the operation energy of which can not be compared with the substantially lower costs of aggregated built in series.

It is not hard to understand the down to earth, subdued attitude. If problems arise in Maglarp both wind-power and the naval yard will be hurt and this kind of wind-power plant might have to be given up entirely.

They are therefore cautious not to use big words. They want to at every cost avoid that Maglarp becomes another Marviken.

Technical Data

Stockholm NY TEKNIK in Swedish 30 Oct 80 p 25

(Article by "Ikael Holmstrom)

[Text] How will the power plant of Maglarp function in the coming fall? The turbine, the turbine hub and the tower constitute the largest risks with regard to the construction. Here are used manufacturing technology and solutions that are as such familiar, but that have not been tested for wind-power plants on such a large scale.

The risks are not related to security (that the blades would not be strong enough, that the tower would fall apart due to vibration). There is the concern that all the details would not function as optimally as predicted by the calculations. If the systems cooperate as they should, the lifespan is the expected one and the maintenance does not demand more time than planned (the plant will be operated unmanned).

This is a short survey of the most important parts of the power plant:

The TURBINE is 79.4 m in diameter and consists of two blades. Both blades are 38 m long, 1-4.7 m wide and 100-1600 mm thick. They are made entirely out of glass fiber armored epoxy plastic. The blades rotate during the production and fiber is automatically wound on. The U.S. plant is just finished and it is the largest and the first one of its kind in the world. The result will be a flexible blade without seams or rivets.

The HUB is a so called seesaw hub. The turbine rotates on the lee side of the tower and the blades have to go through the shadow of the tower where there is less wind. The tower may swing some which also decreases the strains caused by gusts of wind (the outer edge of the turbine swings 1.4 m under normal operation).

The seesaw hub itself is attached to the main shaft of the power plant by means of a principle that has been borrowed from helicopter technology (Delta 3). This means that all the strains of the turbine are not transmitted to the main shaft and the engine house adjusts automatically so that the plane of the turbine is always at a 90° angle against the wind. Apart from that the strain on the tower is decreased.

The GEAR UNIT (delivered by Thyssen Henschel) is suspended with two sets of spring units so that the moment variations will be picked up in order to decrease the strains on the shaft system.

The gear unit is a planetary two step bearing that shifts the 25 rpm of the turbine to the 1500 rpm of the generator.

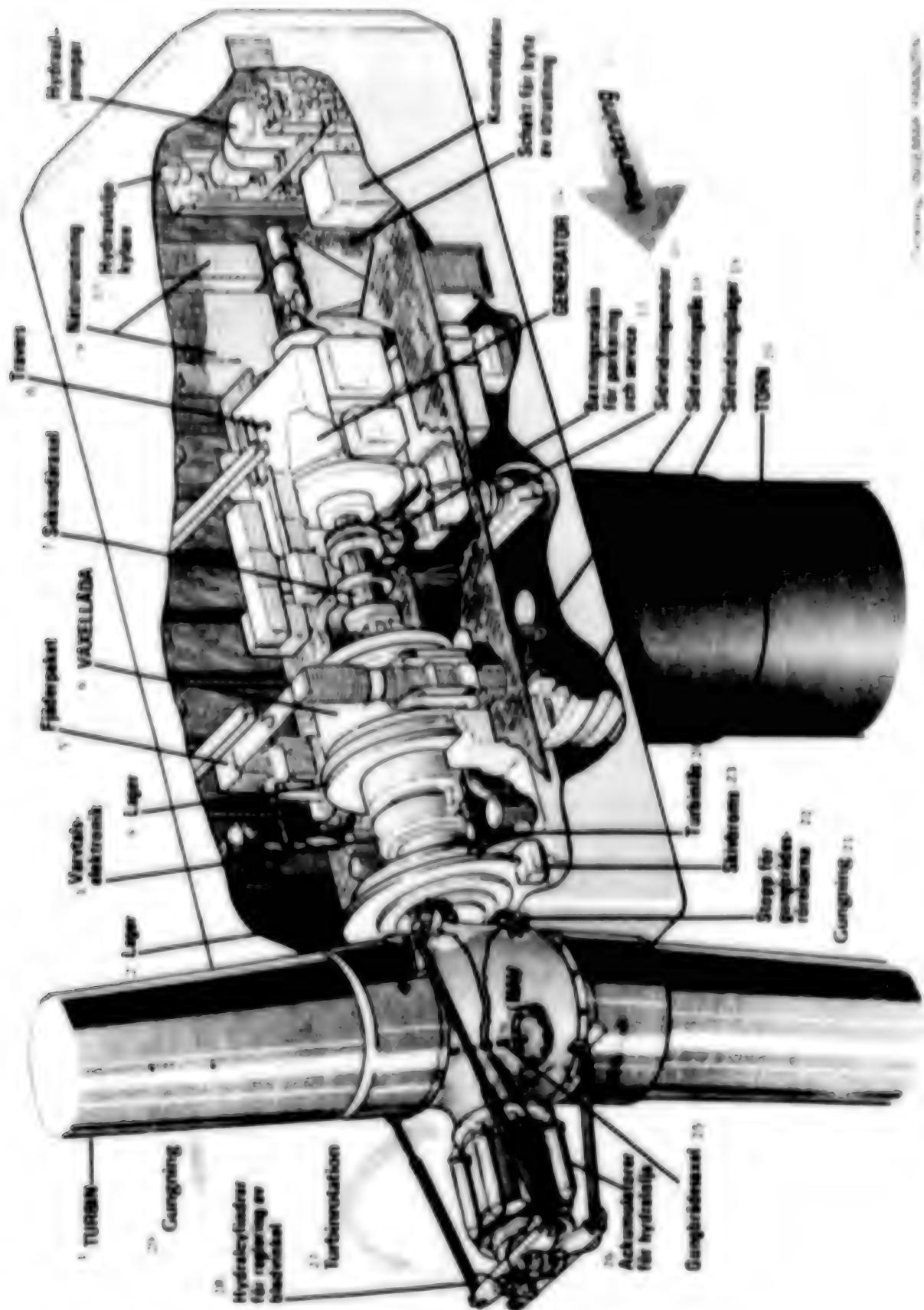
The GENERATOR (Asea) is asynchronous and produces 3 MW. The power plant is switched on at 6 m/s and has a maximal output at 14.2 m/s. Thereafter it "spills" wind up to 21 m/s when it is disconnected. The Maglarp winds will give 8.2 GWh/year (10.3 GWh/year in the United States).

The CONTROL SYSTEM consists of three computers. One computer monitors the operation, one sets the blade angle and evaluates incoming values and one connects the system to the circuit. The computers receive information from 120 different senders. (Teleb and Foa are working with program development.)

The setting of the blade angle, which is accomplished by means of hydraulics, is very fast and turns the blades up to maximally 95° depending on the strength of the wind. The speed (8°/s) decreases the strains of the shaft system.

The TOWER is built out of steel and it is 77 m high. It is shaped as a cylinder without inner bracing. The thickness of the plate is 15-44 mm and the diameter only 3.8 m. The steel tower has a horizontal ring of 4.5 m diameter in its bottom.

The FOUNDATION consists of a concrete disc of 19 m diameter. The tower is attached by means of bolts onto the 3 m high concrete plinth built into the center of the disc. The outer edges of the disc are below the ground. (AIB is responsible for the construction and is also working on the engine house.)



Key:

1. Turbine
2. Bearing
3. Speed electronics
4. Bearing
5. Spring unit
6. Gear Box (in boldface)
7. Secondary shaft
8. Traverser
9. Circuit equipment
10. Hydraulic oil cooler
11. Hydraulic pumps
12. Control computer
13. Shaft for changing equipment
14. Generator
15. Shifting machine for parking and service
16. Laterally turning engine
17. Direction of wind
18. Lock of lateral turning
19. Bearing of lateral turning
20. Tower
21. Swinging
22. Stopper for seesaw movements
23. Disc brake
24. Turbine
25. Seesaw shaft
26. Accumulators for hydraulic oil
27. Rotation of turbine
28. Hydraulic cylinders for setting of blade angles
29. Swinging

9662

CSO: 3102

HIGH EFFICIENCY SOLAR CELL DEVELOPED, TESTED

Milan ALTA FREQUENZA in English Nov-Dec 80 pp 419-423

[Article by Mario Conti and Alberto Modelli]

[Text]

Abstract. The design, fabrication and performance of a high efficiency 2" silicon solar cell are described. This cell is based on the N⁺P structure which was optimised to deliver the maximum power under concentrated sun light, typically 20X - 50X. The cell is soldered on a metal base which provides a quick and reliable mounting and interconnection. Its reliability, as ascertained by a test programme which includes humidity test, salt spray and thermal fatigue, allows the prediction of a satisfactory life performance for a long period of time.

1. INTRODUCTION

Within the framework of the Italian 100W Concentration Photovoltaic Module the SGR/ATIE was charged with the development and the production of the 140 photovoltaic solar cells required to equip the Module.

Basic specifications for the cell were:

- Circular solar cell with useful internal diameter of 44 mm to be employed with a circular lens at 50X concentration ratio.
- Efficiency at 50X higher than 15%.
- The cell was to be mounted on a metal base with two headers in order to provide quick and reliable mounting of the cell to the mainframe and efficient connection to the circuit.
- The cell had to provide a reliable energy production in the temperature range 0-65°C for a long period of time.

In this option an R and D activity was carried out in the following areas:
a) design and optimisation, b) fabrication, c) characterisation, and d) reliability tests of the cell.

2. DESIGN AND OPTIMIZATION

At the beginning both the N⁺P and PIN structures were considered but the latter was disregarded since it appeared to require some silicon processes up-to-date not well established in SGR/ATIE. Furthermore the simple N⁺P structure can also provide a very high efficiency, up to 18% as reported by J.CASTLE et al. (1). To achieve the maximum performances this structure was reconsidered with respect to the bulk material doping, N⁺ surface layer and front metal grid design.

Bulk material. The optimum doping of the P type bulk material was chosen to obtain the maximum efficiency. At low doping the open circuit voltage V_{OC} is low and the short circuit current density J_{SC} is high (2). As the doping increases, V_{OC} also increases, but the lifetime decreases and so does also the energy gap of silicon. As a consequence the collection efficiency η , and J_{SC} decrease. Accounting for the correct expression of all the physical variables the conversion efficiency can

be computed and appears to feature a maximum in the doping range $0.5 \text{ to } 1 \text{ } 10^{17} \text{ cm}^{-3}$ [2]. So 0.3 to 0.5 $\Omega \text{ cm}$ P type (111) oriented 2" silicon wafers were employed as bulk material. Additional cells were processed on 1.25 and 4 $\Omega \text{ cm}$ material.

- Surface layer. The N^+ region is normally designed to provide:
- a minimum recombination for the holes which are generated by light absorption in the N^+ and P regions, diffuse in the N^+ region and recombine in the bulk and at the surface.
 - A small absorption of incident photons in the useful range of solar spectrum.
 - A negligible reduction of the fill factor up to the maximum concentration ratio.

Points a) and b) require a low doped, very thin N^+ region since the smaller is the doping the lower is the recombination both in the bulk and at the surface. On the other hand, point c) requires a highly conductive layer in order to limit the voltage drop in the N^+ region due to the photo generated current which flows parallel to the junction.

A planar N^+ junction obtained by standard diffusion with PCl_3 at 900°C -9 min was employed.

It provides a low sheet resistance $\rho_0 = 50 \Omega$ combined with a thin junction depth $x = 0.3 \mu\text{m}$. Doping and mobility profile of this N^+ layer are reported in Fig. 1.

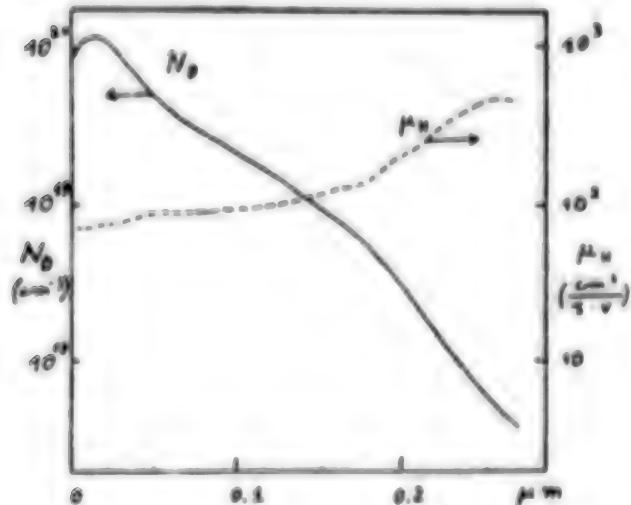


Fig. 1-Donors and mobility profiles of the front N^+ region.

The front contact grid was chosen to minimize the total energy lost by resistive drop in silicon and in the metal and because of shadowing of solar light. The two configurations considered have a geometrical covering ratio of approximately 9% (fig. 2).

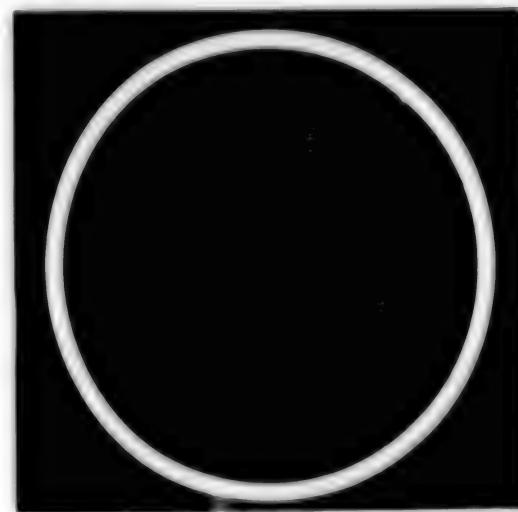
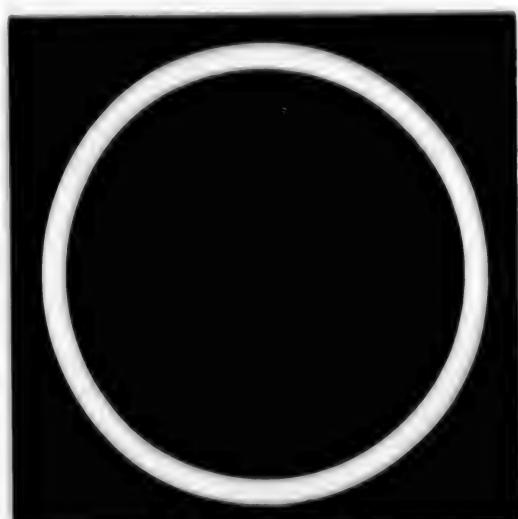


Fig. 2-Front metal grids for the SPV-050 solar cell

3. CELL PRODUCTION

2" (111) oriented PZ silicon slices doped in the range $0.3 \text{ to } 0.5 \Omega \text{ cm}$ were chosen as a bulk material [3]. The wafers were 30μ etched both sides in order to remove the surface damage so that $250 \text{ to } 300\mu$ thick wafers were obtained. On the front a planar N^+ junction was obtained by the standard diffusion with PCl_3 at 900°C , 9 min, followed by a slow cool resulting in a junction approximately $0.3\mu\text{m}$. $2\mu\text{m}$ of Al were deposited by evaporation on the back and alloyed at 500°C , 30 min. This layer provides a good P^+ back contact and an efficient reflection of long wavelength photons.

A front contact grid was obtained by lift-off technique with the standard Ti/Pt/Ag (50, 50, 60 nm) metallization followed by electrochemical deposition of silver (10 μ m). A SEM micrography of a metal finger is shown in Fig. 3. Its broadening due to the lateral growth of silver is clearly visible.

The inner diameter of the ring is 44 nm, the nominal covered area is 9% which increases to approximately 14% after the electrochemical growth of silver.

A triple layer of Cr, Ni, Au (50, 30, 30 nm) was deposited on the back by evaporation. Finally the front was covered with 75 nm of Si₃N₄ deposited by r.f. plasma at 190°, to form the antireflection coating. The cell is soldered by a tin-lead preform on a nickel plated steel frame previously dipped in a molten tin-lead alloy.

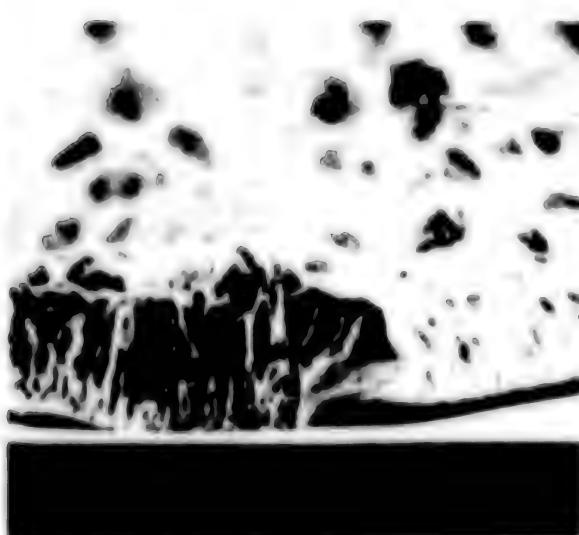


Fig. 3-SEM micrography of a silver finger.

Two spring loaded contacts connect a copper ring soldered over the front metallization to two feed-through headers of convenient diameter. Finally the cell is coated with a layer of silicone rubber. The completed cell is shown in Fig. 4.

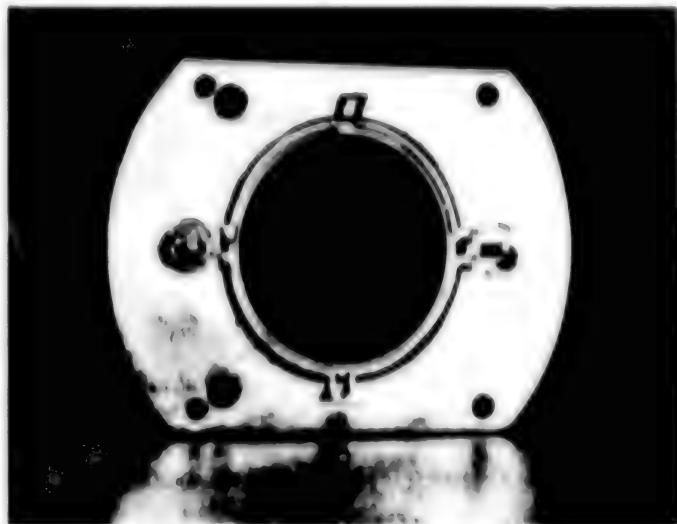


Fig. 4-The SFV-090 concentration solar cell.

4. CELL CHARACTERIZATION

As antireflecting coating (ARC) a TiO₂-SiO₂ double layer and a Si₃N₄ monolayer were considered in alternative. Spectral response of typical cells in the two cases are shown in Fig. 5.

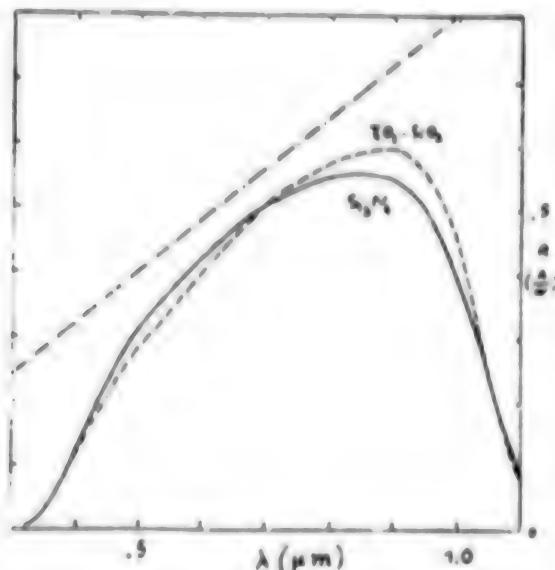


Fig. 5-Spectral responsivity of the cell with two different ARC layers.

As well known the short wavelength part of this plot is controlled by the N⁺ diffusion. In the present case the response is relatively high compared with the high doping and low sheet resistance employed. The long wavelength side is controlled by the thickness of the cell and the diffusion length of carriers.

The latter was computed by plotting the quantum efficiency as a function of the reciprocal of the absorption coefficient $1/\alpha$ [4]. The diffusion length resulted typically in the range 120-160 μm , that corresponds to a lifetime of about 10 μs . The front surface reflectivity of diffused cell in the two cases of $\text{TiO}_2\text{-SiO}_2$ and Si_3N_4 ARC is shown in fig. 6.

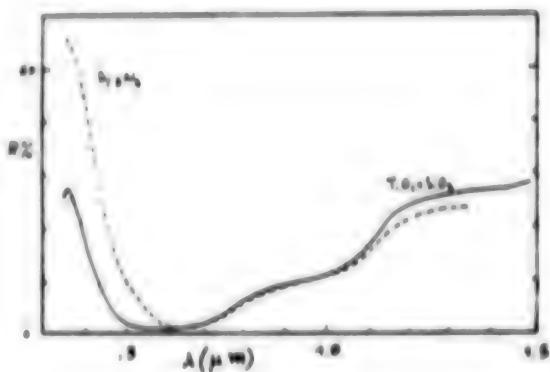


Fig. 6-Reflectivity of the diffused cell with two different ARC layers.

Although the total solar energy lost by reflection is smaller in $\text{TiO}_2\text{-SiO}_2$ ARC, this device was not employed because some degradation was noticed in relative humidity (RH) test.

On the contrary plasma deposited Si_3N_4 did not show any deterioration.

As a matter of fact the I_{SC} performances measured at AM1 resulted to be not smaller than with $\text{TiO}_2\text{-SiO}_2$ ARC.

V_{OC}. As predicted by theory the V_{OC} depends on blocking performances on N⁺ front layer and upon doping of P bulk material.

The experimental trade off in cells carefully processed on FZ silicon is shown in fig. 7.

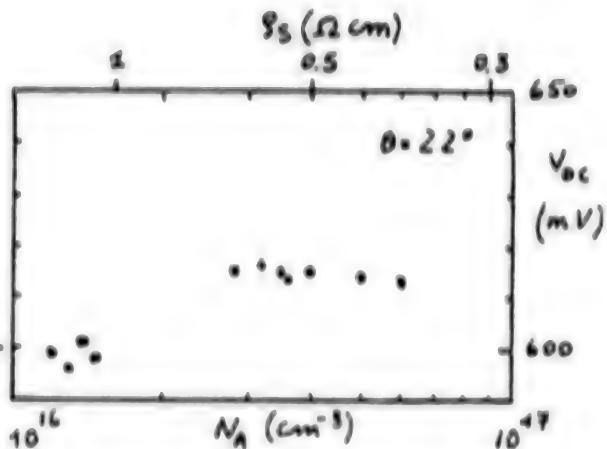


Fig. 7- V_{OC} as a function of bulk doping N_A .

Doping was computed measuring the CV plot of the cells.

Histogram of the V_{OC} relative to 100 cells is reported in fig. 8. The distribution is peaked at 612 mV.

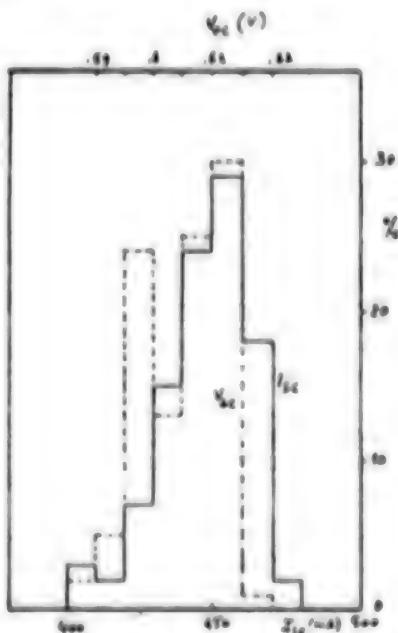


Fig. 8-Histograms of V_{OC} and I_{SC} . Batch of 100 cells.

I_{SC}. The AM1 histogram of I_{SC} relative to the same batch of cell is also shown in fig. 7. The distribution is peaked at 450 mA which corresponds to $J_{SC} = 29.6 \text{ mA/cm}^2$.

When the metal coverage is taken into account a net $J_{SC} = 34.4 \text{ mA/cm}^2$ is obtained. An additional 5% increase is achieved as the cell is coated with silicone rubber which proved to be very useful in improving the resistance of the cell during salt spray and R.U. tests.

5. EFFICIENCY

The performances of a typical SPV-050 solar cell are shown in fig. 9. Measurements were done in direct sun light properly focused on the cell by an acrylic Fresnel lens.

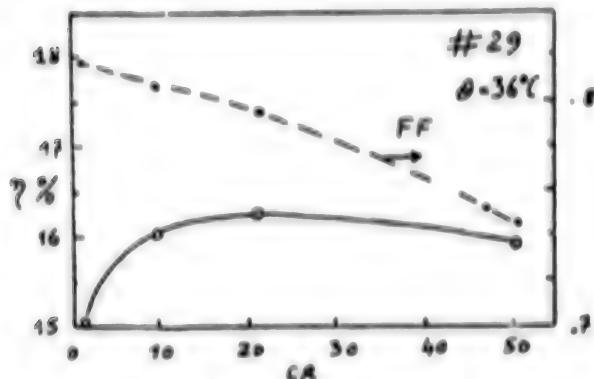


Fig. 9-Efficiency and FF as a function of concentration ratio CR.

The concentration ratio CR was computed assuming proportionality between CR and I_{SC} . The efficiency at 36°C is 15.0% at 1X, achieves the maximum value 16.25% at 20X and is higher than 15.9% at 50X.

Since the temperature coefficient is about -3%, the efficiency at 28°C appears to be 16.7% at 20X and 16.3% at 50X.

The FF is 82% at 1X and is a slowly decreasing function of CR.

The temperature dependence of V_{OC} and FF at 45X is shown in fig. 10. The temperature coefficient of V_{OC} is $-1.67 \text{ mV/}^\circ\text{C}$ while that of I_{SC} at 1X is $+0.12\%$.

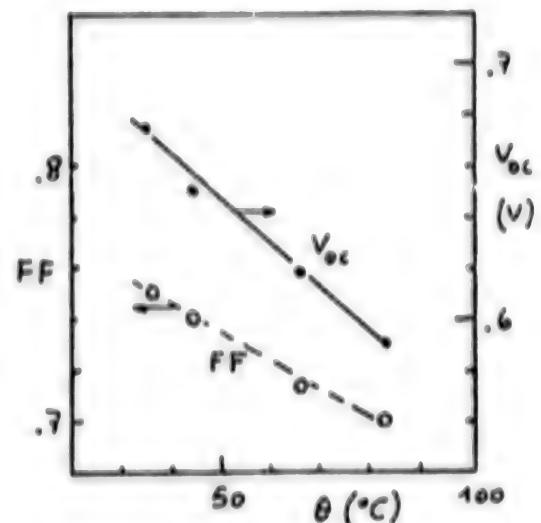


Fig. 10- V_{OC} and FF at 45X as a function of cell temperature.

The power-voltage plot for this cell is shown in fig. 11.

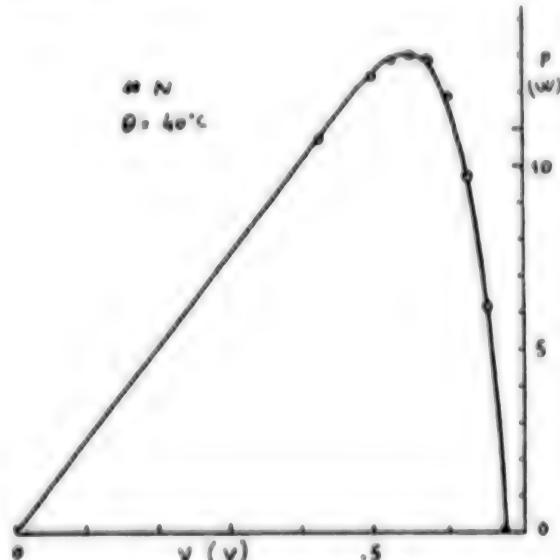


Fig. 11-Power voltage plot for a typical cell at 50X, 50°C.

Open circles are computed values while heavy line is the measured performance.

To interpret the experimental record the actual cell was simulated by a distributed model in which both the resistive voltage drop in silicon and in the front metalization and the shadowing effects are accounted for [5].

Circles in fig. 11 refer to the computer results in the case of shadowing ratio of 14% and metal sheet resistance $2 \text{ m}\Omega$. As shown the agreement is rather satisfactory.

6. RELIABILITY TESTS

Extensive reliability tests were systematically performed on finished cells as well as on individual parts (cell, ARC, metal frame). Basic tests were: Relative Humidity, Salt Spray, Thermal Fatigue [6].

The first one was a thermal cycling between 25 and 65°C at 85-95% R.U., 4 cycles per day. This test revealed an insufficient resistance of the $\text{TiO}_2-\text{SiO}_2$ ARC. However the plasma deposited Si_3N_4 passed the test.

To provide an additional protection the finished cell was coated with silicone rubber. Such cells did not show any sign of degradation or corrosion after several thousand hours of R.U. test.

Salt spray. Some tests were performed following the standard MIL-883P-1009.8. No degradation was noticed both on cell and on metal frame.

Thermal fatigue. A thermal cycle between 30°C and 100°C was obtained sending a 30A d.c. current in the cell for a convenient period of time. Then the cell was cooled to 30°C. Early samples were heavily damaged by this test featuring the detachement of the cell from the metal frame and from the front copper ring. However through a refinement of processing steps and an accurate choice of materials the present devices pass even a 5000 cycles test without any degradation neither visible nor electrical.

CONCLUSION

The industrial feasibility of a silicon solar cell featuring 13W and 25A at 50X was demonstrated.

The AM 1.5 efficiency of the cell approaches 17% at 20X and 16.5% at 50X, 28°C. The reliability tests performed on the cell allow the prediction of a reliable working operation in the actual environment conditions.

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Manuscript received on February 5, 1980

CSO: 3102

SOLAR POWER STATION TO BEGIN OPERATION IN JANUARY

Stockholm NY TEKNIK in Swedish 11 Dec 80 p 10

[Article by Hans Werner: Solar Power Station Ready for Operation]

[Text] Sicily: The world's first big solar power plant connected to an existing supply network is beginning its operations in January, after a delay of 2 months. It was constructed by the EC-countries France, West Germany and Italy and is located in Catania, Sicily.

The plant, having cost about 270 million kronor, will produce 1 MW of electricity and has a thermic capacity of 4.8 MW. Built by the Italian Ammiansaldo, the French Cethel and the German MBB, the station has 6,216 sq.m of mirrors, of which 112 come from MBB each of which has the size of 23 sq.m and 70 from Cethel with the size of 52 sq.m.

The 182 mirrors follow the sun (that is, it is a heliostat) and concentrate the radiation into a steam generator located on the top of a tower, 55 m high.

The plant's steam data is 512 degrees Celsius, 6 MPa, and heat depository containing melted salt and warm water is assumed to conserve the heat for half an hour.

The steam propels a turbo generator which supplies the electricity to the Italian power network, Enel.

The heat depository has been added to enable the plant to function even during periods when clouds, for short moments, pass over this otherwise very sunny area in Southern Europe. Special care has been bestowed upon the radiation neutralizing equipment, which explains why the steamboiler and turbine can reach a factor of efficiency of over 90 percent.

The project is part of the EC-countries' research and development program for the use of solar power. During a period of 4 years 270 million kronor have been invested, half of it directly by the EC. The program includes five projects, which now will be supplemented by an additional two for the second period of the program, which runs from July 1979, to June 1983.

The two new projects are in the fields of wind power and solar power utilization in agriculture and industry. The earlier projects, beside the solar power plant on Sicily, relates to solar power in housing construction, photovoltaic power generation, energy from biomass etc.

ENERGY

POWER FROM VERTICAL-AXIS WIND GENERATOR FOUND NOT CHEAPER

Stockholm NY TEKNIK in Swedish 20 Nov 80 p 3

[Article by Ake Bergh]

[Text] The Poseidon vertical-axis wind turbine has now been examined in a preliminary engineering study. It emerges from a recently completed report that the design does not have any demonstrable advantages over horizontal-axis wind generators.

The report, which was commissioned by the Energy Production Research Board (NE), contains a tentative cost estimate for the unit at various sizes.

As regards cost effectiveness--which measures investment costs against the price of the electricity that the system can produce--the vertical-axis (VA) generator is shown to be approximately in line with its horizontal-axis (HA) competitors.

The figures are based on known facts, and the investigators now want to go further and make a more complete study of the less thoroughly tested components of the VA design.

It is considered that one of the design's advantages--compared to an HA unit--is that the engine house and most of the moving parts are located at the base of the structure. The report does not say what that means as far as reducing maintenance costs is concerned. The investigators, who constitute a team consisting of the Scandinavian Engineering Corporation (AIB), the Swedish National Defense Research Institute (FFA), Saltech, and Olle Ljungstrom, consider the design viable.

The NE, which financed the pilot study, feels that it has gained useful knowledge on the subject.



Vertical-axis rotor: not cheaper.

Borje Lindstrom of the NE says, "We are chiefly interested in gaining domestic competence in this area. We have not yet decided whether we will invest money in further studies of the design."

Darrieus Principle

The vertical-axis wind generator is based on a design by engineer Olle Ljungstrom, who works as a wind energy consultant in Stockholm.

The generating plant works on the so-called Darrieus principle and is characterized by a twin-blade construction in which the blades are placed at a 90-degree angle to each other.

The base of the tower--which is similar to a TV tower--is mounted on a rotating bedplate. The bedplate rests on a number of horizontal roller bearings. The generators are driven via a coupling gear directly from some of the rollers.

The full-scale wind generating plant is designed chiefly to operate as an offshore system (standing on the sea bottom), with a large number of units being located in a limited area.

According to the pilot study, a wind generator producing 20 MW of power would have a tower between 150 and 180 meters high.

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ENERGY

FUNDS, COORDINATED PROGRAM NEEDED FOR EFFECTIVE ENERGY RAD

Frankfurt/Main BLICK DURCH DIE WIRTSCHAFT in German 18 Dec 80 p 3

[Text] Frankfurt, 17 Dec--Seven years have passed since the oil crisis of 1973. The Federal Government and the Laender have worked out energy programs. A number of laws, regulations and guidelines have been issued. International corporations have presented innumerable expert opinions on the energy situation. In the area of energy research as well, in 1973 big promises were made by the state. In particular in nonnuclear energy research there was talk in the Federal Government of a large effort. It is high time to subject the period from 1973 to 1980 to a more careful investigation and to ask what has been done.

If we compile the expenditures of the state for nonnuclear energy research, then we obtain the figures presented in Table 1.

Support for Nonnuclear Energy Research by the Federal Government
(Expenditures in million DM*)

Period	1973-79	1980	1973-80
1. Coal	1,624.5	295	1,919
2. Rational energy use	490.8	75	566
3. New energy sources	430.8	145	576
4. Budget administration	83.9	22	106
Total	2,630	537	3,167

*Source: Federal Budget Plans 1980, section 3005, annual report 1979 PJE Juelich.

Thus, in the period from 1973 to 1980, the Federal Government has made available about DM 3.1 billion for nonnuclear energy research in the form of project grants, administered by the Federal Ministry for Research and Technology. Besides this aid to specific research projects, there is naturally a number of research projects in the different research institutes which are not included as nonnuclear energy research in the budget plans. For example, in many nuclear research centers today, up to 30 percent of expenditures is for nonnuclear research. These amounts are not included in the above table. These figures represent only funds declared by the Federal Government in its energy research programs to be for nonnuclear energy research. But they represent by far the largest amounts spent for energy research.

The definite emphasis of previous state measures in the area of nonnuclear energy research since the oil crisis is the promotion of coal research, for which 60 percent of all funds were spent. For research into new, regenerative energy sources, DM 576 million was spent in the entire period from 1973 to 1980, that is, about 18 percent of all state research funds. For instance, the United States alone spent twice as much on solar research in 1980 as the FRG from 1973 to 1980. From this fact alone we see that research into new energy sources has not been emphasized in previous nonnuclear energy research of the Federal Government.

After 7 years' promotion of coal research by the Federal Government, large-scale facilities could indeed be erected in a short time, but this probably will not happen very fast since the necessary funds for implementation were not appropriated. Furthermore, a series of environmental, siting and approval aspects are still uncertain. Besides coal research, regenerative energy sources are gaining importance at least in the political sphere, without this being reflected accordingly in budgetary planning.

The establishment of the previous funding emphasis with solar energy and other regenerative energy sources has definitely not taken place according to objective criteria, but was born more from the fervor of the moment. This can be verified by comparing previous expenditures with the theoretically possible amounts which could be contributed to the energy supply by solar energy, wind energy, biomass and geothermal energy. This is shown in Table 2.

Regenerative Energy Sources and Their Funding by the Federal Government 1973 to 1979

Area	Percent of R&D Funds	Priority		
		1	2	None
1. Photolysis facility				x
2. Solar cell	26.1	x		
3. Thermal collector	18.6	x		
4. Hydroelectric power plant				x
5. Glacial ice power plant				x
6. Wave power plant				x
7. Wind energy converter	28.3	x		
8. Ocean current power plant				x
9. Ocean heat power plant				x
10. Heat pumps	3.9	x		
11. Bioproduction power plant, conversion	-			x
12. Combined facilities	5.7		x	
13. Administration	2.3	x		
14. Geothermal energy	14.9		x	

If we arrange the previous total expenditures to the individual areas as is done in the table, then we see that the expenditures of the Research Ministry have been concentrated on wind energy, solar cells and collectors. The entire range of long-term oriented solar research is considered a priority of the Research Ministry.

The main reason is that the political decision-makers wish to see research successes as quickly as possible so that they can publicise them. This explains the concentration of solar energy research by the ministry on projects to be presented to the public after 1 to 2 years in order to show that something had been done.

In addition it would also be necessary to support practical application of the research results: But this is being done only in part, partly by state purchasing programs and by the energy savings write-off. The regulation of tax concessions and energy writeoff for use of solar facilities is designed and written without reference to thermal insulation, so that regenerative energy sources used by consumers in the last 7 years are negligible. There can be no talk of a breakthrough.

The sole area where market success is seen is that of heat pumps. Thanks to private initiatives and especially high oil prices, greater sales success has been achieved. This will continue in coming years.

On an international scale, the efforts of the Research Ministry to promote nonnuclear energy research and the use of these research results are valued critically. In 1979 the state energy research expenditures of the Western World were about 7.7 billion dollars.

Of this amount:

--nuclear research and technology took 54.7 percent

--regenerative energy sources 11.8 percent

--other nonnuclear energy research, especially in the area of coal, petroleum and natural gas, 33.7 percent.

Expenditures of the Federal Government for energy research in 1979 were about DM 2 billion. Of this amount, not even 5 percent was for regenerative energy sources; this is about DM 100 million. In the entire Western World therefore, the FRG is at the lower end in supporting nonnuclear energy sources; above all compared to the United States, it drops off in comparison to the research potential. The United States has been paying about 70 percent of research expenditures for regenerative energy sources in the West. But its share of the total research potential of the West is only 50 percent. If other nonnuclear energy research, especially coal research, is included in this overview, then the picture for the FRG is not much better. We are then somewhere in the middle.

France, which has a very large nuclear energy program, has about 40 percent lower expenditures for nuclear research and technology, but much higher expenditures for regenerative energy sources than does the FRG. France is a typical example for the fact that technological research, for example nuclear research, is simply not enough, rather there must be a significant policy for converting the research results into fact.

If the present style of energy policy continues, then there will be no great success for nuclear research and technology nor for the use of regenerative energy sources. The state support of energy research and its linkage to the application of research results in the FRG is insufficient. We are dealing not only with research means, but with a coordinated program of research and application. Organizational or political restrictions to the use of known research results aimed at substituting oil or for energy conservation must be dismantled. But this is being done in Germany only on a very small scale.

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CSO: 3102

ENERGY

BRIEFS

CONFERENCE ON BIOMASS ENERGY--The first European conference on energy drawn from the biomass was held recently in Brighton, England. Plants and trees absorb solar energy which they store naturally. In time, they are transformed into fossil fuels; however, man is able to accelerate this process thanks to technical processes which permit their transformation, with various organic wastes, into fuels. Plants, trees and wastes are collectively designated by the term biomass. Biotechnology is a new field which is developing as scientists and engineers seek a means of commercially exploiting wastes which, at a time when there was an abundance of oil, were considered fit to be discarded. It is estimated that in Great Britain energy drawn from the biomass could meet 8 percent of present fuel needs. Research programs are being conducted--particularly at Reading University near London--which involve special cultures to be used for the production of energy; e.g., quick-growth trees; the possibility of growing seaweed; the production of methane from wastes. As regards all of the EEC, it is estimated that energy produced by these techniques could reach the equivalent of 95 Mt [?thousand tons] of oil per year. [Text] (Paris SEMAINE DE L'ENERGIE in French 8 Dec 80 p 10) 8143

SYMPOSIUM ON NEW ENERGIES--A symposium on new energies was held in Sousse, Tunisia, at the end of October at the initiative of the French-Arab Chamber of Commerce. Very important French industrial groups sent their representatives to this symposium: CdF Chimie-COPENOR (expansion unknown); the Renault Group; Creusot-Loire Company; Liquid Air Company; FRAMATOME (Franco-American Atomic Construction Company); Alsthom-Atlantic; CGE (expansion unknown); French Petroleum Company; ELF Aquitaine National Company; Dumez; etc; and many Arab countries were represented. During the symposium, presentations were made by the delegates from Algeria, Syria, Morocco, Jordan, Saudi Arabia, Kuwait, Lebanon and Tunisia. The presentations dealt principally with the experience of those countries in the sectors of wind energy, nuclear energy and in particular with solar energy programs and their various applications, especially in the agricultural area. In his closing speech, Michel Habib-Deloncle, former minister, president of the French-Arab Chamber of Commerce, emphasized that the policy followed by the oil producers (Arabs and non-Arabs) was based on a concern for conserving an exhaustible energy heritage for mankind as long as possible. Stressing the importance of nuclear energy as a new energy source, the risks of which have been very much overestimated, he expressed the hope that there would be no need for a choice in principle between good and bad energy but rather that concurrent research would be conducted in all sectors in which diversified sources of energy could be discovered and exploited. [Text] (Paris SEMAINE DE L'ENERGIE in French 1 Dec 80 p 10) 8143

COAL GASIFICATION PLANT--France will soon produce gas from coal, thanks to money from the oil sector. The announcement of this production is imminent: a pilot plant capable of transforming several dozen tons of coal per day into gas will be operational 1 year from today. ELP (Gasoline and Lubricants Company of France), CFR (expansion unknown), IFF (French Petroleum Institute), French Gas Company and Creusot-Loire, which will be the linchpin, are involved in this undertaking. The process was purchased from American Texaco but the principal equipment will be French. Gasification is getting a start in France, just as did the nuclear program earlier, on the basis of an American license. It has not been easy to find financing, and that is the reason for the forced association with the oil companies. That is also the reason for delays, as some of the companies have proposed Le Havre as the site and others Feyzin. In a related development, the French Gas Company plans to place a 1,000-ton industrial unit in operation in 1983 on the basis of a process that has not yet been selected. Creusot-Loire is proposing the Texaco system; however, it is not just by chance that a large West German company presented its own process to France a few days ago. The gas produced will not be used to supply the heating plants of private citizens since it is not as rich as conventional gas. A small distribution network will be set up to supply this coal gas to industrialists who will burn it or consume it as a raw material. [Text] [Paris LE FIGARO in French 3-4 Jan 81 p 16] 8143

WIND POWER PLANTS TO FAEROES--NY TEKNIK has learned that the Karlskrona Shipyard has the green light to deliver five wind power plants to the Faeroes. This became clear following talks held in the Faeroes last week. So the shipyard is already engaged in negotiations on two foreign markets--1 year before the first power plant in Sweden is due to be delivered. The other big export deal involves Hawaii, where the shipyard, through its American partner Hamilton Standard, has thus far outdone Boeing and Westinghouse in the negotiations. If the whole deal goes through, it will involve from 20 to 25 power plants. The Faeroes are interested in quick delivery, but the shipyard wants to wait until it can evaluate experience with the two power plants it will deliver next year to government energy researchers in Sweden (Maglarp [expansion unknown]) and the United States. Those power plants have an output of from 3 to 4 MW with a turbine diameter of 80 meters. The Faeroes are somewhat in the same situation as Hawaii: it is very windy, and the islands depend on diesel generators for most of their electricity production. To begin with, there will be five power plants, meaning an installed capacity of about 20 MW. The installation can be made without taking any steps as far as the rest of the electricity production system is concerned. The wind power plants can then replace diesel units and reduce the rate of water flow in hydroelectric power plants. Farther in the future, the possibility also exists of building pumped storage hydroelectric plants in the Faeroes to take advantage of what water there is--there are no glaciers and consequently no continuous runoff of water. [Text] [Stockholm NY TEKNIK in Swedish 27 Nov 80 p 3] 11790

CSO: 3102

SCIENCE POLICY

NEW DEVELOPMENTS IN CERAMICS RESEARCH REPORTED

Stockholm TEKNIK I TIDEN in Swedish No 4, 1980 p 9

[Text] The Silicate Research Institute in Gothenburg, along with the Glass Research Institute in Vaxjo, is one of the smallest trade institutes in Sweden. The research deals with most aspects of the ceramics trade, from glazes on common porcelain to new ceramic materials for automobile motors. The institute, which receives half of its funds from the STU (Board for Technical Development) and the other half from the industry, does not have the possibility of investing in any unique projects.

"With 15 employees, we must concentrate on trying to keep up with developments in the leading countries in the field. The work is important so that Sweden will not fall behind in international competition," says the head of the institution, Roger Carlsson.

For a year now, the institute has concentrated, among other things, on producing high-quality high-temperature ceramics. The materials, which consist of silicon carbide or silicon nitride, have several properties that make them of interest, for example, in producing internal combustion engines. The ceramics can withstand temperatures up to 1,400 degrees without needing to be cooled. By making those engine parts that are subjected to high temperatures out of ceramics, engine operating temperatures can be raised significantly, and therefore their efficiency can be raised as well.

"The material has the same strength as steel, but is considerably lighter. The raw material is quite abundant. High-temperature ceramics can also be used in the future for, among other things, ball bearings, cutting tools, and fluidized beds," says Dr Leif Hermansson of the institute and head of the high-temperature project.

Ceramic Research

"The United States, Japan, and West Germany are investing large sums in ceramics research, and it is research that is being carried out primarily by private institutes and companies, which are often very secretive about their results. We can obtain some information during study visits, but to keep abreast of developments we must repeat certain experiments that have been done abroad," says Roger Carlsson.

"In 5 to 10 years, ceramic technology may have developed to the point where some company can demonstrate an operational engine prototype. By that time, the conventional car motor may certainly be considered outdated, since it is estimated that a ceramic motor will be 20 to 30 percent more efficient."

One of the difficulties that remains to be solved is how to produce large parts made of silicon carbide. One method used today is injection molding of the ceramic material, using plastic as a supporting materials. The plastic, which comprises 40 percent, is burned away and the ceramic part is then sintered together at a high temperature. The problem, however, is to construct a furnace capable of handling the high temperatures—over 2,000 degrees—which are needed.

There is some cooperation with institutes abroad. A project designed to produce a new kind of crystallized glass out of slag from steel production has been carried out in cooperation with a corresponding institution in Bangladesh. The glass, which is completely black, can be used, for example, as a construction material.

New Program

In 1978 a new research program was started at the institute. The program, which was developed in conjunction with the STU and interested parties from industry, will continue for 3 years and includes five projects. One task of the project committee is to see that industry can put the research results into practice as quickly as possible.

The examination of glazes is one of the projects, and last year the release of cadmium from porcelain glazes was investigated.

"The experiment showed that, in practice, the release of cadmium in connection with porcelain is negligible," says Roger Carlsson.

"In cases where cadmium, in the form of cadmium sulfide, has been deposited on the outside of a glaze, it would take around 100 years for all the cadmium to be released into the ground water, for example, at a dump. On the other hand, if it has been deposited under the glaze, the encapsulation would be so tight that it would take an estimated 16,000 years for complete dissolution."

"In addition, the decorations that are made with cadmium coloring, for example, on coffee cups, is never on the inside of the cup where the metal could possibly be dissolved. Cadmium compounds are the only red colors known that can be used for glazes. If we stop using them then we must do without the red coloring on porcelain," says Roger Carlsson.

The institute is also trying to solve problems with lead glazes on stoneware. At present, restaurants and kitchens are forced to throw away a lot of porcelain because of metal discoloring from silverware on plates.

Rejects

Silicon dioxide, which is used in the foundry industry for lining induction furnaces, creates great problems for the working environment when the furnaces are torn down.

One of the research projects is aimed at finding refractory dry pastes that can be used for the lining.

"We are testing various types of neutral and basic pastes," says Roger Carlsson. The advantage of these is that neutral and basic slags can be used in the furnaces. With dry pastes, it would also be possible to line directly all types of furnaces.

Another important project includes the attempt to reduce the number of rejects in the production of porcelain, plaster molds, and enameled products.

"At present, the number of rejects in the ceramics industry can be as high as 25 percent," says Roger Carlsson. "Our task is to better understand and improve production processes. However, we can do nothing about what is perhaps the main reason for the high number of rejects—the Swedes' demand for quality, which is much too high."

"A single little spot, for example, on a toilet seat or a plate means that the product must be rejected, unless it is possible to sell it on the foreign market, which is rare since the products are heavy and difficult to ship."

Discoloration takes place during firing. The products are placed in furnaces on porous slabs—so-called firing aids—primarily of silicon carbide. The slabs are oxidized relatively rapidly and form cracks, which cause silicon carbide grains to fall down on the products, causing spots.

The institute hopes to be able to reduce the problem by including calcium and iron in the slabs.

9336
CSO: 3102

TRANSPORTATION

FIRST DANISH-BUILT AUTO OF RECENT TIMES MARKETED

General Information

Copenhagen BERLINGKSE TIDENDE in Danish 10 Dec 80 p 14

[Article by Kiraten Sørrig: "New Danish Automobile Made at the Mill in Løgten"]

[Text] "Of course it is possible to make a Danish automobile. I cannot understand at all that production has not already been under way," says Engineer Bent Due, the man behind the first Danish-produced automobile in recent times.

The automobile is called the Safari and resembles a cross between the Beach Buggy and a jeep and is being produced at the old mill in Løgten in Djursland, where the Due family has lived since 1978.

Colossal Interest

The Safari is being introduced at the Christmas fair in Aabenraa from 5 to 20 December and has created a great sensation. So great that Bent Due is completely frustrated. "I have no idea what I will do with this colossal interest. We have already gotten orders for over 140 cars. A single customer in Germany wants 1000 and several developing countries have also placed orders, but we can produce at most one car a week. I am a little frustrated over the fact that the car which has been my hobby for four years has in a few days become the car which everybody is talking about," says Bent Due.

He has already found a sole dealer for the car from Sjaelland but would like to build up a dealer network across the entire country. "However, I am not especially interested in having a large company. It becomes too much administrative work and is too difficult to manage. I am only interested in a small firm in which I can be involved all the time, for I like best to have blackened fingers," relates Bent Due.

Japanese Inspired

He has been trained as an engineer, automobile mechanic and electromechanical technician and got the idea for the car during a stay in Nigeria under the developing country assistance program. "I wore out one car after the other. Even expensive

German-produced cars lasted 30,000 km at best. Finally I bought myself the most durable and functional Japanese jeep ever. It was indestructible and gave me the inspiration for the Safari. The only problem was that it weighed almost 2000 kg."

Danish Conditions

The new Safari weighs 550 kg and the weight-assessed tax is 430 kroner per year. It travels between 14 and 16 km on a liter of gasoline and is made of fiberglass and galvanized tubing to suit Danish conditions. "The car is made so it can withstand Denmark's climate. It will not rust. It drives through half-meter-high snow drifts without trouble. It is inexpensive. It has good gasoline economy, is durable and can be used to transport the whole family," relates Bent Due.

A Family Business

The only Danish automobile plant is a family business led by Connie and Bent Due. There are five employees, plus three children who are very interested in the Safari. "The car will be a Danish car. Eighty percent of it is made in Denmark and it must continue in this manner. Perhaps we can expand production by hiring a few more people or by acquiring a few subcontractors," says Connie Due.

For the time being the Safari will be sold in a somewhat special manner. Customers' orders are written up, they order a color and pay 10,000 kroner as a deposit. The Due family tells when the car can be delivered and a contract note is signed. When the car is finished it can be picked up with a cash payment of 39,040 kroner. "In olden days people could wait up to a half year to have a horse-drawn carriage made by a cooper. So they can also wait to get a good and inexpensive car," says Connie Due.

Crisis Car

Bent Due has nothing against the fact that the car is being characterized as a crisis car. "But I will certainly not agree with those critics who say that a drive in it is a rough and crisis-characterized experience. I can agree that it has the aerodynamics of a shoe box, but who can demand to drive over the abyss in first class?"

Further Details

Copenhagen BERLINGSKE TIDENDE in Danish 7 Dec 80 p 11

[Article by Finn Knudstrup: "Here Is the Danish Car"]

[Excerpts] The car is a 3.25-meter-long jeep type with two comfortable front seats and a narrow bench seat in the rear. It is based on the technology of the old Volkswagen, i.e., with an opposed-cylinder engine in back and the gasoline tank in front. On top of this familiar subject Bent Due has placed a fiberglass body supplied by an Arhus boat firm. However, Bent Due maintains that only the engine is identical to the old Volkswagen's. The other parts come from Danish concerns, including from Østergaard in Jutland and Rouland on Fyn. The engines are

half Danish in that they are rebuilt Volkswagen engines rebuilt by using Danish spare parts.



Here is the first Danish car in recent times. It is called the Safari, costs 40,000 kroner and is built at a mill plant near Århus.

When one sits in the car, however, it is a question of a VW type 1 with a fiber-glass shell on top. The car behaves exactly like the classic VW and Bent Due has also carried over this car type's instrumentation, gear box and seating system to his Safari. However, Bent Due, who has a background as an automobile mechanic and an engineer in the Air Transport Service, has succeeded in reducing the car's weight by 300 kg as compared with the VW type 1.

The Safari is certainly an inexpensive car. It is less expensive than the 2 CV and the small Fiat cars. It is also inexpensive when one takes into account the fact that it is hand built.

Bent Due has invested 500,000 kroner in automobile production. He earned this money when stationed in the Middle East and the total will indeed return home. In any case the automotive engineer says that he has orders for so many Safaris that the six-man auto plant in Løgten has plenty to do next year. All the same a small dealer chain for the Danish car is opening in a month. The first sales room will be in Roskilde. And the Danish auto will also be exported--a couple of Due's friends in the Middle East have ordered some Safari models.

8985
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TRANSPORTATION

CARS TO USE NO MORE THAN .85 LITER GAS PER 10 KM BY 1985

Stockholm SVENSKA DAGBLADET in Swedish 20 Dec 80 p 29

[Article: "The Auto Industry About More Fuel-Efficient Passenger Cars: New Emission Requirements Will Upset Fuel Target"]

[Text] In 1985 new passenger cars in Sweden are not to use more than .85 liters per 10 km. "We are well on our way to meet the Parliament's guidelines," says Jonas Gowell, Executive Director of the Auto Industry Association.

He has just delivered a report to the government. It shows that fuel consumption has decreased for each new model and year, measured by the average consumption and using the guidelines of the Consumers' Office to indicate the consumption:

1978	.93 liter/10 km	1980	.90 liter/10 km
1979	.92 liter/10 km	1981	.88 liter/10 km

"The market forces are the strongest driving forces behind this development, stronger than the guidelines from the authorities in various countries," says the Auto Industry Association (which is a joint body for auto-makers and auto-importers).

United States: Target Will Be Reached With a Margin

Probably, there is some truth in this. Ever since the price of oil began sky-rocketing low fuel-consumption has become a strong argument when the family is about to trade in their car.

It is, of course, also true that the ceiling set by the U.S. Government (which Sweden has adopted) has pushed the issue.

U.S. auto-makers now even say that they can make things improve even faster. General Motors, which has lowered the consumption of its auto production by 81 percent from 1974 to 1980, is expecting to reach .78 liter/10 km in 1984 and .76 liter/10 km the following year. The auto-makers in France, Italy, Great Britain and West Germany have pledged to lower the consumption by about 10 percent before 1985.

1990: .1 Liter More Efficient

The Swedish Parliament has also declared that cars being sold in Sweden in 1990 shall, at most, have a fuel consumption of about .75 liter/10 km, which implies a reduction by a further .1 liter.

"Nobody is prepared to make such promises," says Jonas Gavell, "but the average figures will be more than insignificantly lower" than those of 1985."

"An End to Further Emission Control"

However, if Swedish cars are to meet the guidelines, says the Auto Industry Association, the authorities cannot raise any demands for emission control and for reducing the noise level, which will increase fuel consumption.

Even today the same cars in Sweden use 5 to 7 percent more than in other parts of Europe due to our special rules for emission control.

If further requirements for emission control are implemented, as has been suggested by a commission, fuel consumption will increase by 2 to 6 percent, also according to the auto industry.

Efficient As Well As Pure ... ?

Here lies, of course, a conflict.

If those who sell cars here in Sweden even before 1985 can reach a fuel consumption level which is below .85 liter/10 km on average, should we not be able also to afford better emission control (and tests that check that the cars really stay pure)?

It now seems rather obvious that cars in 1985 will stay below the ceiling of .85.

But Jonas Gavell maintains that it is not possible to combine an average consumption below .85 liter/10 km with emission rules as set out by the most recent suggestion.

And even if this were the case: "Can we afford it? Do we not have to save every drop of gas?" he says.

A thought to which another can be added: If cars were to become even kinder to the air, maybe we could then be spared some of these traffic clearances that have made labyrinths out of several Swedish cities.

This Is How Much Fuel This Year's Car Models Use:

This Is How Much Fuel This Year's Car Models Use:

This is how much fuel the cars being sold as 1980 models in Sweden have used on average. As shown, some car models ALREADY use less than the .85 liter/10 km the Parliament has required for 1986!

[Boxed item]

General Agent	Fuel Consumption
Alfa Romeo	.96
Citroen	.94
Dat sun	.84
Fiat	.80
Ford	.94
Porenade bil (BMW, Honda)	.82
General Motors	.87
Matreco (Vaz)	.99
Olle Olsson (Mazda)	.78
Peugeot	.84
Philipssons (Mercedes, Talbot)	1.00
Renault	.77
Saab-Ana	.94
Toyota	.80
Volkswagen	.76
Volvobil	.99

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TRANSPORTATION

AIRBUS INDUSTRIE: FURTHER DEVELOPMENT, MARKETING PROSPECTS

Paris AVIATION INTERNATIONALE in French 15 Dec 80 p 19

[Article signed PC]

[Text] While the announcement by Boeing of the introduction of a new version of the B-737 with a different engine, hinted at by the directors of the American manufacturer at the end of summer in Farnborough, is expected from day to day, Airbus Industrie, for its part, seems to have established its priorities.

Three possibilities for enlarging the present Airbus A-300/A-310 series have been under consideration for a long while: the development of a long-range, four-engined, 200 seat, wide-body jet, the TA-11; that of an increased capacity version of the present A-300, going up to 350 seats, designated TA-9; and finally the construction of a medium-range, conventional body, 130-160 seat plane (SA). No decision has yet been made officially as to the level of priority among these three options. A market study carried out by Airbus Industrie has, however, led to clear results.

"We see a convenient market for the SA rather quickly, at the end of 1985 or beginning of 1986," Roger Beteille, AI general manager, recently stated in Toulouse. On the other hand, the markets for the TA-9 and the TA-11 should only open up 2 years later, toward 1987, a coincidence of date which encourages the planning department to adopt a common wing for both planes. It is no longer a question therefore of ranking the degrees of urgency, but simply of knowing whether, as of 1981, Airbus Industrie is capable of inaugurating the SA program.

It is a secret to no one: unanimity does not reign among the present partners of Airbus Industrie as to the advisability of inaugurating a new program the cost of which is presently estimated at around a billion dollars. German authorities in particular do not seem very anxious to incur new expenses or appreciably increase the work force of their industry.

It is doubtless these divergences which caused Beteille to say: "If we commit ourselves to the SA, we will probably do so within the framework of widened cooperation." Among potential new partners, Japanese industry is generally cited, decidedly very much solicited and equally solicitant, and the Fokker Company of the Netherlands, concerning which many people doubt that it will be able to carry out its F-29 project, even with Japanese help. Whatever the makeup decided upon, it will be necessary, in order to meet the dates for entry into service resulting from the market study, to reach a decision during the first half of 1981.

While awaiting this deadline, current news is being made by the decision to introduce the A-300-600 version (cf AMI No 791, p 26), which will replace the A-300B on the assembly line starting in 1984. This development should cost around \$200 million and will have with the A-310 a range of capacity well adapted to the market. It is henceforth sure that several companies will transform a portion of their present options on the A-300B into orders for the A-300-600. Thai International could be one of these.

The specifications of the A-300-600 having been 95 percent set, there remains however, the question of what motorization the first plane will have. Three engines are possible: the General Electric CF6-80 Cl, the Pratt and Whitney JT9D-7R4H1 (both with a thrust of 56,000 pounds) and the Rolls-Royce RB.211-524 D 4 (with a thrust of 53,000 pounds). The choice is up to the first customer company. Well, it is expected this will be Saudia, which already uses a fleet of "Tristars" equipped with another version of the RB.211. This confers a theoretic advantage on the Rolls-Royce, but in any case the competition will be very fierce.

The calendar of the development of the A-300-600 has been set as follows: factory issuance May 1983, first flight early July 1983, certification February-March 1984, first delivery March 1984.

These future developments now rely on a well-established trademark: 114 planes in service among 20 companies, 600,000 hours of airline flight time, and especially a technical availability rate of the craft stable at between 98 and 98.5 percent for the entire fleet (over 99 percent for the three leading companies).

As of 2 December, 38 companies had signed contracts for 292 firm orders and 157 options. Five other companies had decided in favor of Airbus Industrie but the contracts were not yet signed.

During the first 11 months of 1980 Airbus Industrie obtained orders from seven new companies, including Tunis Air (the first North African company), Kuwait Airways, Austrian and Varig. The names of two others were not revealed, but one of them had previously ordered Boeing 767's (China Airways?). A total of 39 A-300/A-310 planes were ordered during the same period. The target set at the beginning of the year was to sell 60 planes during the 12 months. This target probably will not be reached, but taking into account the general overall economic situation, it was very ambitious. From 1 January through 27 November, 78 short/medium-range, wide-body (two aisle) jets were sold in the world: three DC-10-10, four L-1011-1, six B-747 SR, 26 B-767 and 39 Airbus A-300/A-310, or half of the world total. This inspires confidence in the future.

Long Term Airbus Industrie (AI) Market Expectations
No. of planes in service by end of 2,000

Category	Present AI Customers	Others	Total
SA1/SA2	575	1,176	1,751
A310/B767-200	323	827	1,150
A300/B767-300	345	366	711
TA9	579	1,049	1,628
TA11	167	280	447
	1,989	3,698	5,687

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